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EXPLORING FUTURE FLOOD MANAGEMENT: A COMPARISON OF SCENARIOS FROM LITERATURE AND STAKEHOLDER PERSPECTIVES[1]

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ABSTRACT: Scenarios are useful for exploring potential flood management strategies under different sets of future conditions. There are numerous ways of developing scenarios. This paper compares an often-used set of scenarios from literature with the perspectives of flood management stakeholders in the Rhine basin. The comparison shows that the autonomous developments, strategies and related links differ between the two approaches, which have different strengths and provide additional insights. An important finding is that variety of autonomous developments in the scenarios from literature is broader than in the perspective-based scenarios. In addition, scenarios from literature are better grounded in science and offer, often quantitative, data about many aspects of the future. On the other hand, developing scenarios using stakeholder perspectives may result in scenarios that are better tailored towards specific situations, and in a stronger feeling of ownership by stakeholders.

Key Words: flood management, scenario, stakeholder perspective, Rhine

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1. INTRODUCTION

The future is highly uncertain and to some extent unpredictable. Future developments, such as climate change, and socio-economic and institutional developments, may have a significant impact on flood probability, potential damage and flood management strategies. Therefore, it may be useful for flood management stakeholders to get prepared for a variety of possible futures, using sets of scenarios, which are plausible and consistent pictures of how the future might unfold.

There are a large variety of scenarios approaches (See for example Parson et al., 2006; Ringland, 1998; van 't Klooster and van Asselt, 2006; van der Heijden, 1996). Scenario studies may have different goals, such as prediction, exploration or strategic planning (Börjeson et al., 2006). Sometimes the term scenario is reserved for autonomous developments, and sometimes scenarios concern management strategies as well. Distinguishing between autonomous development and management strategies allows for assessing the performance of different strategies under different possible future conditions, i.e. the robustness of strategies. However, what can be influenced and what not depends on who you ask, and there often is a fuzzy 'boundary area' between autonomous developments and strategies. Furthermore, scenarios can be developed in different ways, for example in desk studies, by expert groups, or in participatory processes. Consequently, the form and content of scenarios may vary, e.g. from qualitative storylines about institutional developments to detailed quantifications of the effects of climate change.

In this paper, we compare different sets of scenarios concerning future flood management. One set has been developed using 'archetypes' from literature and the other is based on stakeholder perspectives. In section 2, we introduce the context of the scenario development, which is a participatory scenario study concerning future flood management in the Rhine basin. In section 3, we describe a set of scenarios that was derived from literature. In section 4, we discuss stakeholder perspectives on future flood management, which were elicited using Q methodology. Subsequently, we compare scenarios from literature with stakeholder perspectives and identify similarities and differences. We conclude with a discussion of strengths and weaknesses of the two scenario development methods, and some final remarks on their applicability in different situations.

2. CASE STUDY 'FUTURE FLOOD MANAGEMENT IN THE RHINE BASIN'

Flood management concerns a broad range of stakeholders with different perspectives on problems and solutions, in particular in transboundary river basins. Flood management strategies can have upstream and downstream effects and therefore policymakers in different areas are dependent on each other (European Commission, 2004). In the Rhine basin, the research projects ACER and NeWater initiated a participatory process, in which policymakers, scientist and NGOs from Germany and the Netherlands have the opportunity to discuss expected developments, the desired future situation and (joint) strategies to achieve the desired situation. The aim of the process is that the stakeholders learn from each other and from the additional (expert) knowledge that is introduced. This learning may result in convergence of individual perspectives into a joint vision on future flood management.

Concrete products that the process is intended to deliver are 1) 'external scenarios' (sets of autonomous developments) and 'strategies' (sets of flood management measures), and 2) an evaluation of strategies under different external scenarios, based on jointly formulated criteria. In order to develop these products, interviews and questionnaires are conducted and four stakeholder workshops are organized. At the time of writing, the project is in an intermediate state. Stakeholder perspectives have been elicited using interviews and Q sorting questionnaires, the results of which are presented in section 4. Furthermore, two workshops have taken place, in-between which a team of scientists prepared a set of scenarios based on literature (See section 3). Evaluation of strategies will be supported by hydrological, hydraulic and damage modeling.

3. SCENARIOS FROM LITERATURE

Developing storylines requires definition of thematic, spatial and temporal boundaries, as well as key variables, including driving forces and impacts, and their relations. Moreover, critical uncertainties towards the future have to be selected. Numerous scenarios have been produced at global, European and more local levels. Common to most of them are five key drivers to change, which are demography, economy, style of governance, technology and social and political values, and a combination of them into two, most decisive dimensions of uncertainty: values and governance (Berkhout et al., 2002). The 'values' dimension (horizontal in Table 1) represents political and social priorities and the distribution of public and private responsibilities: on the one end rights of the individual, self-interest, reactive, liberal and rational behavior, and on the other end communitarian orientation, with concern for pro-active, sustainable management of common goods, social solidarity and cohesion. The 'governance' dimension (vertical in Table 1) describes political and economic power relations and spatial and structural orientation of decision-making: on the one hand globalization with international alliances and interdependencies, on the other hand regionalization with national and regional autonomies and boundaries. Based on these common storylines, literature offers many sets of different future developments, such as economic growth and climate change, for different scales, sectors and geographic areas. Scenario sets based on other dimensions, such as the 'Perspective Frame' derived from the cultural theory (e.g. van Asselt et al., 2001), are not discussed to limit the length of this paper.

In the case study, the described storylines were adopted, as well as the data concerning specific developments that have been derived from the storylines. Because of geographic and substantial similarities with the case study, the research team used the Dutch WLO scenarios (Janssen et al., 2006) and the English Foresight scenarios (Evans et al., 2004) most intensively to develop relevant scenarios for the case study. These two scenario sets cover all autonomous developments that are relevant for flood management. In addition, the Foresight scenarios, and in less detail also the WLO scenarios, link each set of autonomous developments to a set of flood management measures. This allows for comparing the link between autonomous developments and strategies in literature and in stakeholder perspectives. The scenario names and abbreviations that are used in the case study, and in the remaining of this paper, are presented in Table 1 (bold text).

Table 1. Commonly used scenarios displayed along the 'values' and 'governance' dimensions

Governance

Globalization

Values *Self-interest, Efficiency*		*Solidarity, Equity*
IPCC-SRES: A1 GEO: Market first MA: Global Orchestra WLO: Global economy Foresight: World Markets **Case study: Market (MA)**	IPCC-SRES: B1 GEO: Policy first MA: Techno. Garden WLO: Strong Europe Foresight: Global Sustainability **Case study: EU**	
IPCC-SRES: A2 GEO: Security first MA: Order for strength WLO: Transatlantic Market Foresight: National Enterprise **Case study: National Identity (NI)**	IPCC-SRES: B2 GEO: Sustainability first MA: Adaptive Mosaic WLO: Regional communities Foresight: Local Stewardship **Case study: Regional Sustainability (RS)**	

Regionalization

4. STAKEHOLDER PERSPECTIVES

Perspectives are more or less consistent and enduring cognitive representations of external reality and the position of the individual in this reality, as seen by the individual. Perspectives include technical knowledge, assumptions, interests and values concerning a specific issue. There are many ways to elicit

stakeholder perspectives. In the case study, semi-structured interviews were used to explore perspectives on future flood management and to collect relevant statements for a Q sorting questionnaire. Q methodology (Stephenson, 1953) was used to elicit and analyze perspectives of a broader group of respondents, in a more comprehensive, explicit and objective way. First, respondents systematically sorted 46 statements about current flood management, autonomous developments, strategies and desired situation in 2050, based on their personal agreement with the statements. A total of 47 stakeholders performed the Q sorting, with a good balance between Dutchmen and Germans and government and science. Some viewpoints may be missing, as NGOs, citizens, businesses and German scientists were relatively underrepresented. The validity of the individual perspectives was tested by comparing them to individual interviews and cognitive maps, which were developed at the first workshop. The results indicated that Q sorts identified many developments that were not discussed in the interviews and cognitive maps as relevant. On the other hand, a few topics discussed during interviews were not covered in the Q sort statements, and Q sorting did not allow for detailed explanations. A few Q sort statements appeared to contradict the interviews and cognitive maps.

Using quantitative factor analysis, individual perspectives were aggregated into three shared perspectives, which explain 43% of total variance between individual perspectives. Factor analysis allowed for aggregating individual perspectives into four shared perspectives as well, but this resulted in two very similar perspectives, which now have been combined. By aggregating individual perspectives, communication, apprehension and comparison became easier, but it decreased nuance and richness of the overview. The number of respondents, from different backgrounds, that determines each perspective is displayed in Table 2. Respondents 'determine' a shared perspective when their individual perspective positively correlates with it in a statistically significant and clean way. Clean means that correlation with one shared perspective is clearly higher than correlation with other shared perspectives. Eight individual perspectives did not have a clean correlation, and three did not have a significant correlation with one of the shared perspectives. Finally, the logic of the shared perspective was identified, and the shared perspectives were named. The following summarizes the main future developments and proposed measures in the shared perspectives (See for more details Raadgever et al., 2008).

A. **'Anticipation and institutions'.** The largest group of respondents, among which many flood experts of local governments, shares perspective A. They expect numerous significant developments: climate change will significantly increase peak discharges, the potential damage in flood-prone areas will increase significantly and increasing spatial pressure will lead to a decreasing range of possible measures to minimize flood risks. Thus, it is important to act quickly. Appropriate physical measures are managing the rural landscape and holding back water in the basin upstream, to adjust timing of peak flows from the main tributaries. Dike heightening is considered a less effective and efficient option. Desired institutional changes include transboundary harmonisation of methods to determine safety standards, creating a simple governance structure and a strong river basin authority, and better integration of water management and spatial planning.

B. **'Space for controlled flooding'.** Mainly German, high-level government actors share perspective B. As in perspective A, the message in perspective B is that fast actions are required, mainly because spatial pressure on the river is increasing. It is desired that, in 2050, the Rhine still offers opportunities for a broad range of user functions and the river landscape is open and enjoyable to live and recreate in. Strategies are concentrated at minimising potential damage, by controlled flooding and compartmentalisation, and by mitigating socio-economic developments. As in perspective A, a simple governance structure is considered useful and dike heightening is considered ineffective and/or inefficient. Holding back water in the basin (locally) is not considered to contribute to decreasing peak discharges of the Rhine.

C. **'Knowledge and engineering'.** The respondents that determine perspective C, mainly Dutch scientists, agree that expert knowledge should play a larger role in policymaking. Priority in the long-term is to establish safety against flooding rather than to improve spatial quality. An important future development is improvement of expert insights due to better computer technology and models. In the desired future situation, the Rhine offers opportunities for a broad

range of user functions, and safety standards are differentiated based on values to protect. There is no endeavour to relocate dikes and revitalise the riverbanks. The proposed strategy is technically led, focused on dike heightening and better maintenance of existing rivers, floodplains and dikes. In addition to norm differentiation, damage in case of flooding should be reduced by controlling socio-economic developments, which requires a closer integration of water management and spatial planning.

Table 2. Number of respondents (N) per category (SCI = Science, GOV = Government, SOC= Society (NGO, citizen and business), DE = Germany and NL = the Netherlands) and per shared perspective

Factor	N_{GOV}	N_{SCI}	N_{SOC}	N_{DE}	N_{NL}	N_{TOTAL}
Determining factor A	9	6	3	9	9	18
Determining factor B	10		1	9	2	11
Determining factor C	2	4	1		7	7
Total	21	10	5	18	18	36

5. COMPARISON SCENARIOS FROM LITERATURE AND STAKEHOLDER PERSPECTIVES

5.1 Indicators and scores

Scenarios from literature and shared perspectives were compared using indicators concerning autonomous developments and strategies. Only aspects that were covered in Q statements were used for comparison and included in the final set of indicators (see Table 3), understanding that scenario literature describes much more aspects of the future. Aspects that were covered in Q statements were aggregated as far as this made sense considering the correlation between perspective scores on different Q statements. Developments that could not easily be categorized as autonomous development or strategy, which were primarily institutional developments, have been treated as autonomous developments.

For each of the indicators, four score categories (1 to 4) were described qualitatively, for example as ‘stays like current situation’ or ‘strong increase’, reflecting the range of developments in the scenarios. Scores on strategy indicators reflect the relative attention to each measure in a scenario and not the absolute amount or investment, which is for example much higher in MA than in RS. Then, for each indicator a score was assigned to each scenario, based on storylines (and sometimes more quantitative data) in literature. Q statement scores were used to determine indicator scores for each perspective, often combining scores on multiple relevant statements into one indicator score. Statement scores were linked to qualitatively described score categories. For example, a score of +3 on the Q statement ‘Potential damage will increase until 2050’ indicates an expected ‘large increase’, and is translated to a score of 4 on the indicator scale, ranging from 1 to 4. This required some interpretation by the authors.

Results from the scoring exercise are summarized in Table 3. Because from the table it is not obvious which scenarios from literature and stakeholder perspectives correlate well, additional analysis was performed. First, the deviation between each scenario and perspective was determined by calculating the square root of the sum of quadratic differences between indicator scores, assuming an equal weight for each indicator. The quadratic differences were summed for autonomous developments and strategies separately. Secondly, the relative position of scenarios and perspectives was visualized in a graph with two axes (individual-collective and local-global). For each indicator, it was determined which of the axes it concerns, and how original scores could be ‘projected’ onto the axes. Subsequently, average scores on both axes were calculated for the autonomous developments in each scenario and perspective. Because in our logic the strategies could only be linked to values and not to governance, we could not make a two-dimensional graph for the strategies.

Table 3. Indicator scores for scenarios from literature and shared perspectives (on scale 1-4)

Indicators	Scenario (literature)				Perspective		
	MA	EU	NI	RS	A	B	C
Autonomous developments							
Developments in flood prone areas	4	2	3	1	3.7	3.7	3
Increase multi-functionality river area	1.5	3	1.5	4	2	3	2
Growth new technology / productivity	4	3	1.5	1.5	1	2	4
Power of basin commission	2	4	2	2	4	2	2
Interplay between sectors	2	3	2	3	4	3	4
Informal transboundary cooperation	3.5	3	1	2.5	2	3	4
Attention to public participation	1.5	3	1.5	4	4	3	3
Use of scientific knowledge	4	2.5	2.5	1	2	2	4
Long term view	1	4	2.5	2.5	3.5	2.5	3.5
Awareness and preparedness	2	4	2	2	3	4	4
Active anticipation in management	2	4	2	2	4	3	2
Focus on economic efficiency	4	2	3	1	2.3	2.3	3.3
Level of safety norms	4	3	2	1	3	1.7	2.3
Differentiation of safety norms	4	2.5	2.5	1	3	2	4
Strategies							
Dikes, dams	4	1.5	3	1.5	1	1	4
Storing water in the basin	1	4	2.5	2.5	4	1.5	2.5
Retention near the river	2.5	3	2	2.5	3.7	2.3	1.7
Warning / disaster management	3.5	2.5	1.5	2.5	3	4	3
Legal restrictions (spatial/building)	1.5	4	1.5	3	2	4	3

5.2 Similarities and differences

Autonomous developments

For each perspective, it was identified which scenarios deviate least, and thus are most similar to it. Results indicate that A, B and C all match best with the EU scenario. Attributes on which the perspective match relatively well with the EU scenario include a high awareness of and preparedness for disasters, a moderately high interplay between sectors, informal transboundary cooperation, attention to public participation and increase of multi-functionality of the river area. Perspective A deviates most from the EU scenario concerning expected developments in flood prone areas (A expects more,) and concerning growth of technology and productivity (A expects less). On these aspects A is most similar to the NI scenario. Perspective B and C both expect a lower power of basin commissions than in EU scenario, as in all other scenarios. Furthermore, B expects more developments in floodplains than EU and does not adopt such a long-term view, and matches second best with the RS scenario. Perspective C expects a lower anticipation of change than EU, as well as more intensive use of expert knowledge in policymaking and stronger differentiation of safety norms. On all these points it fits nicely with the MA scenario.

Figure 1 shows the position of perspectives relative to the position of scenarios from literature on the ‘values’ and ‘governance’ axes. It appears that perspectives A and B and the EU scenario match well, and that perspective C is somewhere in-between the NI and MA scenario. These results are similar to the results of the multi-dimensional comparison described above, which may be more valid, as it simplifies less. More interestingly, Figure 1 indicates that scenarios from literature cover a broader spectrum of possible futures than stakeholder perspectives. First of all, the orientation towards the value and governance axes differs more strongly between scenarios from literature than between perspectives.

Secondly, the scenarios are more extreme pictures of possible futures, at least when displayed along these axes.

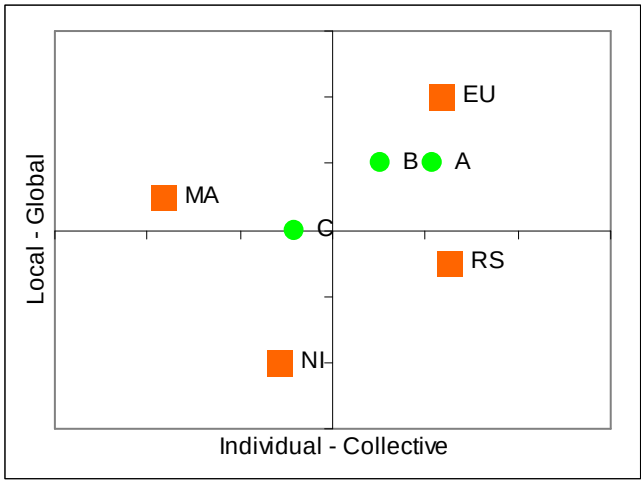

Figure 1. Position scenarios from literature and stakeholder perspectives along the 'values' and 'governance' axes, for autonomous developments

Strategies

Concerning strategies, perspective A again is similar to the EU scenario, focusing on storage in the basin, retention and disaster management. However, A pays less attention to legal restrictions concerning developments in flood prone areas. Perspective B and C match best with the RS scenario, in which the investment in storage and retention is limited. B matches second best with EU due to a strong focus on legal restrictions and little investments in dike heightening. C matches second best with NI, with a relatively strong focus on dikes. The strategy in the MA scenario differs strongly from those in the perspectives. C is most similar, but differs as a consequence of the higher focus on legal restrictions and storage in the basin. Projected on only one dimension, the value axis, scenarios EU and RS are on the collective (right) side and MA and NI are on the individual (left) side, as can be expected. Perspectives A and B are located on the far right, close to EU, and C is located just left of the middle, close to MA.

6. DISCUSSION AND FINAL REMARKS

This paper compares a set of four scenarios based on literature with three measured shared stakeholder perspectives on future flood management, and identifies major similarities and differences. For the comparison, only indicators for which a direct link between the two scenario sets could be established were used. Climate change, for example, was not included as indicator, because climate change effects as expected by the stakeholders are not directly comparable to the effects as defined in the scenarios from literature. The main reason is that stakeholders, when performing a Q sort, express their personal perspective without considering a direct coupling with other perspectives concerning cause-effect relations. For example, respondents with perspective C expect a large growth of technology and productivity, but relatively little climate change effects, despite the obviously high emissions of such a scenario. There may be a number of reasons for the distinct logic applied in the different perspectives. These include different expectations concerning feed-back mechanisms, such as the influence of mitigation measures, different values and interests that influence expectations, such as a desire for economic growth or for ecological precautionary, and different local interpretations of global effects.

It is also not easy to establish logical links between sets of autonomous developments and matching strategies. Concerning autonomous developments, all identified perspectives are most similar to the EU scenario, whereas concerning strategies, only one perspective is most similar to EU, and the others

correspond best with the RS scenario. Apparently, the connection between autonomous scenarios and related strategies depends very much on interpretations by scientists, for scenarios from literature, or stakeholders, for perspectives, which may be influenced by their values and local experiences. This ambiguity points to the need for assessing different strategies under different sets of autonomous developments scenarios.

An important insight gained is that the variety of possible futures covered by the scenarios from literature is larger than the variety covered by the measured stakeholder perspectives. Because scenarios from literature are developed using a top-down structure, variety between the scenarios, measured along the 'values' and 'governance' dimension, is maximized. In addition to the 'direction' of development, the 'range' of scenarios from literature is larger than the range of stakeholder perspectives, which are much closer to business as usual (See Figure 1). A strong variety of possible futures, offered by scenarios from literature, may be useful to minimize chance of unpleasant surprises. In addition, scenarios from literature are strongly grounded in social and institutional science, and have been elaborated by, for example, economic and natural scientists. Assuming that the scenarios are interpreted in the same way by different scientists, each scenario provides a broad and consistent set of developments, concerning values, governance, socio-economic and physical developments. Many of these developments are elaborated using quantitative models. As a consequence, the availability of quantitative data and, for example, maps on different aspects of the future is large. Data about future developments that are produced by science, in particular quantitative data grounded in models, are often perceived as trustworthier than data derived from stakeholder perspectives. Furthermore, available data may trigger discussions and may be used as model input, e.g. for flood probability or flood damage modeling. However, scenarios from literature do not provide sufficient knowledge in every situation. Their relevance is limited when other uncertainties than values and governance are critical, when other developments than those covered in literature are relevant, or when data is needed at another scale or for another region or sector than is covered in literature. When 'downscaling' or 'translating' scenarios is difficult, it may be useful to develop scenarios bottom-up, for example using stakeholder perspectives. This way, developments that are perceived as relevant by stakeholders can be included in the scenarios, which often are of qualitative character. The main strength of using stakeholder perspectives in scenario development may be that it facilitates the development of stakeholder ownership. Stakeholder-based scenarios may be better understood and easier to relate to knowledge and experience of stakeholders. This may be of particular importance for scenario studies, in which stakeholder participation is important, and which are aimed at social learning between different stakeholders.

Instead of choosing one approach for developing scenarios, insights from science and from stakeholder perspectives may be combined, for example by reformulating scenarios from literature to better reflect stakeholder perspectives. We raise the need for research exploring methods that combine the strengths of different scenario development approaches to overcome apparent trade-offs, such as the trade-off between scientific quality and stakeholder ownership, and to provide better insight into the future.

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